

June 2011

Foreign Exchange Analysis,
2001 - 2005
State Board of Administration of
Florida

MERCER

Contents

1. Introduction.....	2
▪ Scope	2
▪ Sources	2
▪ Methodology	3
2. Execution details, 2001 through 2005.....	7

Appendix A: Foreign exchange transaction cost analysis methodology

▪ Time-stamped data.....	18
▪ Non time-stamped data.....	18
▪ Estimating excess costs for non-time stamped data.....	19
▪ Trading pattern analysis.....	20

Appendix B: Imputed spread by currency pair

1

Introduction

Scope

The State Board of Administration of Florida (SBA) engaged the Mercer Sentinel® Group (Mercer Sentinel) to benchmark its foreign exchange (FX) execution for SBA's twenty global and international investment managers. This study examines data for the 5-year period 1 July 2001 to 30 June 2005. These twenty managers represent those strategies managed as separate accounts, all of which were custodied with State Street Bank & Trust Company (State Street). The analysis does not consider SBA's foreign currency exposure through its commingled investment accounts, which represented approximately 39.4% of SBA's total international and global equity assets (as of 30 June 2005). In this analysis, Mercer Sentinel estimates SBA's total FX execution costs and, where applicable, its excess FX costs.

Sources

SBA's custodian, State Street, provided the FX execution records. Mercer Sentinel has checked the data, but we cannot verify the data accuracy or completeness, as we have no means for verifying what should have been provided. The analysis in this report presumes the data is correct.

State Street did not provide time-stamped transaction data. Absent time-stamped data, benchmarking relies on evaluating execution performance based on the intra-day trading range of the currencies traded, the price at which each trade was executed, and the volume of each trade executed. We use Bloomberg as the primary market data source. Bloomberg is widely accepted in the foreign exchange market as an accurate and reliable pricing information source. Within Bloomberg, we use the BGN FX rate, which has been algorithmically filtered, as opposed to the composite FX rate (ALLQ), which is an unfiltered composite from all contributing dealers. In our experience and estimation, approximately 2% of valid trades fall outside the day's range as reported by BGN. A

more significant out-of-range variance, greater than 2% of transactions, could indicate a potential problem.

During the review period, certain governments remonetized their currencies, notably the Turkish lira and the Mexican peso. We were able to identify currency data that aligned with State Street's reporting conventions for these currencies during the period. The total volume of currencies affected by remonetization processes was about USD \$175 million, or about 1% of total traded volume.

Methodology

In April 2007, Mercer Sentinel acquired rights to software and methodologies originally developed by Record Currency Management Limited, a UK-based currency manager. Since then, Mercer Sentinel has continued to advance the tools and analytical approach supporting this intellectual capital. Notably, we have significantly expanded the system's analytical capabilities to include processing of forward contracts, a major innovation.

As State Street did not provide time-stamped trade data, our analysis evaluates individual trades against the mid-price for the day, and then uses statistical principles to aggregate those individual results into meaningful cumulative results. A fundamental assumption underlying our analysis methodology is that foreign currency trades are normally distributed around the mid-price for the day.¹ "Mid-price" is defined as the average of the recorded high and low prices.

Mercer Sentinel analyzes trades according to trade size, direction (buys and sells), currency pairs, and SBA's execution sources or contract types. SBA's data has sufficient observations to draw statistically significant conclusions for all commonly used ways of assessing the data. Some exotic currency pairs lack meaningful sample sizes; however, these pairs do not comprise a significant portion of SBA's trading activity.

Trade size

Mercer Sentinel allocates trades into three size groups, as shown in Table 1.1.

Table 1.1 Trade sizes

Category	Trade value
Market	\$500,000 or greater
Non-market	\$150,000 to \$500,000
Micro	Less than \$150,000

Trading direction

In this analysis, activity vis-à-vis the US dollar determines trade direction. Buys are trades purchasing US dollars and sell trades are the opposite. Cross trades occur when

¹ Appendix A provides greater detail on our execution analysis methodology.

the transaction does not involve US dollars, such as a Euro to British pound sterling trade. Mercer Sentinel evaluates cross trades separately from buys and sells. Where we identify notable items with cross trades, we highlight them separately.

Currency pairs

Mercer Sentinel classifies the primary global currencies as reserve currencies, and transactions in those currencies as reserve trades. The global reserve currencies are those held in significant quantities by many governments and institutions as part of their foreign exchange reserves. The following are reserve currencies:

- Euro (EUR)
- US dollar (USD)
- British pound sterling (GBP)
- Japanese yen (JPY)
- Canadian dollar (CAD)
- Swiss franc (CHF)

All other currencies are classified as secondary. Any trade involving a reserve currency and a secondary currency is categorized as a secondary currency transaction.

Settlement period

Mercer Sentinel analyzes and reports spot and forward FX executions separately. Based on market convention, Mercer Sentinel considers FX executions settling within three trading days of the execution date as spot executions, and those settling four days or later as forward executions. We analyze spot executions against the day range on trade date and forward executions against interpolated near-term contracts. For example, we interpolate a ten-day forward contract using a one-week and a two-week standard, near-term contract.

Contract type

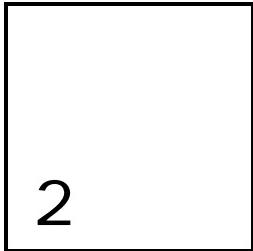
SBA's investment managers instruct FX execution through internal State Street treasury desks or external trading desks. Specifically, the data has three contract types that we analyzed, plus an additional "unknown" contract type

Contract types defined:

- Internal, non-negotiated: Executions in which State Street has discretion concerning time and price of execution. State Street has two internal, non-negotiated contract types: Custody FX (standing instructions) and AIR (auto repatriation).
- Internal, negotiated: Execution orders placed directly with State Street in which the investment manager has discretion concerning the relative time and price of execution

- External, negotiated: Executions performed with third-party brokers, in which the investment manager and third-party broker have discretion concerning time and price of execution
- “Unknown”: Executions for which State Street’s records did not have an assigned contract type

During the period, State Street’s data records contained 24 executions that did not have a specified contract type, but contained all other relevant execution information for analysis. Rather than remove the trades, we report the executions under the banner “unknown” contract type. The total volume of unknown contract type executions is about USD \$16 million (7 basis points of traded value).



2

Execution details, 2001 through 2005

Table 2.1 Aggregate execution profile – spot vs. forward

	Trades		% disadvantageous by value			Excess (cost) / benefit		Bps of traded value
	Volume in # of trades ²	Volume in USD (000's)	Total	Market	Non-market	Micro	USD (000's)	
Spot	30,851	17,776,934	53%	53%	55%	57%	(7,227)	(4.1)
Forward ³	2,185	4,989,900	53%	53%	53%	51%	(1,955)	(3.9)
Total	33,036	22,766,834	53%	53%	55%	56%	(9,182)	(4.0)

² Mercer sentinel removed 247 spot executions due to insufficient information or other data issues: 5 for negative maturity dates, valued to USD 4,882,862; 218 for no comparative data valued to USD 38,512,650; and 24 for executions less than USD 1.00. We further removed 94 forward executions for no comparative data valued at USD 191,595,767.

³ 436 forward executions (20% by number, 4% by volume) did not have sufficient data to interpolate between near contracts; for these executions, valued at USD 189,253,549, we used the nearest, standard forward contract.

Table 2.2 Internal versus external execution outside the day's range by value and frequency, spot only

	2001	2002	2003	2004	2005	Total
Internal, by value	6%	9%	7%	7%	6%	7%
Internal, by frequency	27%	36%	29%	25%	26%	29%
External, by value	3%	2%	2%	3%	4%	3%
External, by frequency	4%	3%	4%	4%	4%	4%
<i>Total, by value</i>	<i>4%</i>	<i>4%</i>	<i>4%</i>	<i>5%</i>	<i>5%</i>	<i>4%</i>
<i>Total, by frequency</i>	<i>12%</i>	<i>15%</i>	<i>14%</i>	<i>14%</i>	<i>16%</i>	<i>14%</i>

Table 2.3 Aggregate spot execution by contract type

Contract By Type	Trades		Excess (cost) / benefit			Percent of Total	
	Volume in # of trades	Volume in USD (000s)	USD (000s)	Bps of traded value	# of Trades	Volume in USD (000s)	Contribution
Internal, Non-Negotiated	7,196	1,691,022	(4,863)	(28.8)	23%	10%	67%
Internal, Negotiated	5,671	4,735,450	(322)	(0.7)	18%	27%	4%
External, Negotiated	17,960	11,334,135	(2,032)	(1.8)	58%	64%	28%
Unknown	24	16,326	(9)	(5.8)	0%	0%	0%
Total	30,851	17,776,934	(7,227)	(4.1)	100%	100%	100%

Table 2.4 Aggregate execution profile by contract type, spot only

Contract By Type	Trades		% disadvantageous by value			Excess (cost) / benefit		
	Volume in # of trades	Volume in USD (000's)	Total	Market	Non-market	Micro	USD (000's)	Bps of traded value
Internal, Non-Negotiated	7,196	1,691,022	75%	72%	79%	86%	(4,863)	(28.8)
Internal, Negotiated	5,671	4,735,450	52%	52%	51%	47%	(322)	(0.7)
External, Negotiated	17,960	11,334,135	50%	51%	50%	47%	(2,032)	(1.8)
Unknown	24	16,326	56%	53%	70%	75%	(9)	(5.8)
Total	30,851	17,776,934	53%	53%	55%	57%	(7,227)	(4.1)

Table 2.5 Aggregate spot execution profile by year, spot only

Year	Trades		% disadvantageous by value			Excess (cost) / benefit		Bps of traded value
	Volume in # of trades	Volume in USD (000's)	Total	Market	Non-market	Micro	USD (000's)	
2001	3,256	1,792,187	52%	51%	58%	54%	(832)	(4.6)
2002	6,791	3,766,313	54%	54%	56%	56%	(1,817)	(4.8)
2003	7,489	3,752,501	52%	52%	54%	56%	(1,409)	(3.8)
2004	9,034	5,672,394	50%	48%	54%	58%	(1,601)	(2.8)
2005	4,281	2,793,539	60%	61%	54%	58%	(1,566)	(5.6)
Total	30,851	17,776,934	53%	53%	55%	57%	(7,227)	(4.1)

Table 2.6 Aggregate execution profile – reserve vs. secondary currencies, spot only

	Trades		% disadvantageous by value			Excess (cost) / benefit		Bps of traded value
	Volume in # of trades	Volume in USD (000's)	Total	Market	Non-market	Micro	USD (000's)	
Reserve	19,643	13,840,227	52%	51%	53%	56%	(4,559)	(3.3)
Secondary	11,208	3,936,706	58%	57%	58%	58%	(2,668)	(6.8)
Total	30,851	17,776,934	53%	53%	55%	57%	(7,227)	(4.1)

Table 2.7 Aggregate execution profiles for Internal State Street only, spot only

Contract	Trades		% disadvantageous by value				Excess (cost) / benefit	
	Volume in # of trades	Volume in USD (000's)	Total	Market	Non- market	Micro	USD (000's)	Bps of traded value
By Type								
Custody FX	3,777	1,402,685	71%	70%	73%	79%	(2,032)	(14.5)
AIR	3,419	288,337	94%	99%	92%	93%	(2,831)	(98.2)
<i>Internal, Non- Negotiated</i>	7,196	1,691,022	75%	72%	79%	86%	(4,863)	(28.8)
<i>Internal, Negotiated</i>	5,671	4,735,450	52%	52%	51%	47%	(322)	(0.7)
Total	12,867	6,426,473	58%	56%	63%	72%	(5,185)	(8.1)

Table 2.8a All internal, Custody FX executions by trade size, spot only

	Total	Market	Non- Market	Micro
Total value of all trades, \$000's	1,402,685	1,023,193	287,837	91,655
Excess benefit (+)/cost (-), \$000's	(2,032)	(1,395)	(385)	(252)
Benefit (+)/cost (-), bps	(14.5)	(13.6)	(13.4)	(27.5)
Total number of trades	3,777	789	980	2,008
Number with excess costs	2,835	591	724	1,520
Percentage disadvantageous by number	75%	75%	74%	76%
Value of disadvantageous, \$000's	997,239	715,152	209,665	72,423
Percentage disadvantageous by value	71%	70%	73%	79%
% within days range (by value)	94%	96%	88%	86%
% within days range (by number)	88%	94%	88%	85%

Table 2.8b All internal, AIR executions by trade size, spot only

	Total	Market	Non-Market	Micro
Total value of all trades, \$000's	288,337	68,265	118,695	101,377
Excess benefit (+)/cost (-), \$000's	(2,831)	(780)	(1,101)	(951)
Benefit (+)/cost (-), bps	(98.2)	(114.2)	(92.7)	(93.8)
Total number of trades	3,419	97	470	2,852
Number with excess costs	3,234	96	433	2,705
Percentage disadvantageous by number	95%	99%	92%	95%
Value of disadvantageous, \$000's	271,453	67,605	109,511	94,337
Percentage disadvantageous by value	94%	99%	92%	93%
% within days range (by value)	7%	2%	7%	10%
% within days range (by number)	10%	2%	7%	11%

Table 2.9 All internal, negotiated executions by trade size, spot only

	Total	Market	Non-Market	Micro
Total value of all trades, \$000's	4,735,450	4,042,648	578,285	114,517
Excess benefit (+)/cost (-), \$000's	(322)	(641)	188	130
Benefit (+)/cost (-), bps	(0.7)	(1.6)	3.3	11.4
Total number of trades	5,671	2,026	1,926	1,719
Number with excess costs	2,839	1,039	993	807
Percentage disadvantageous by number	50%	51%	52%	47%
Value of disadvantageous, \$000's	2,449,815	2,098,402	297,588	53,826
Percentage disadvantageous by value	52%	52%	51%	47%
% within days range (by value)	98%	98%	98%	98%
% within days range (by number)	98%	98%	98%	97%

Table 2.10 All external, negotiated executions by trade size, spot only

	Total	Market	Non-Market	Micro
Total value of all trades, \$000's	11,334,135	9,279,771	1,595,974	458,391
Excess benefit (+)/cost (-), \$000's	(2,032)	(1,977)	(106)	51
Benefit (+)/cost (-), bps	(1.8)	(2.1)	(0.7)	1.1
Total number of trades	17,960	5,216	5,532	7,212
Number with excess costs	8,789	2,686	2,733	3,370
Percentage disadvantageous by number	49%	51%	49%	47%
Value of disadvantageous, \$000's	5,715,843	4,702,860	799,147	213,837
Percentage disadvantageous by value	50%	51%	50%	47%
% within days range (by value)	97%	97%	96%	97%
% within days range (by number)	96%	97%	96%	96%

Table 2.11 Contract type "Unknown" executions by trade size, spot only

	Total	Market	Non-Market	Micro
Total value of all trades, \$000's	16,326	14,032	1,703	591
Excess benefit (+)/cost (-), \$000's	(9)	(4)	(4)	(2)
Benefit (+)/cost (-), bps	(5.8)	(2.8)	(23.0)	(28.1)
Total number of trades	24	11	5	8
Number with excess costs	13	5	3	5
Percentage disadvantageous by number	54%	45%	60%	63%
Value of disadvantageous, \$000's	9,124	7,479	1,199	446
Percentage disadvantageous by value	56%	53%	70%	75%
% within days range (by value)	97%	96%	100%	100%
% within days range (by number)	96%	91%	100%	100%

Table 2.12 Summary table, all spot executions by trade year, spot only

Year	Contract Type	Volume in USD (000s)	Percentage by year	Volume by # of trades	Percentage by year	Excess (cost) / benefit USD	BPS of traded value
2001	Custody FX	\$159,173	9%	492	15%	(\$446,976)	(28.1)
	AIR	\$19,853	1%	286	9%	(\$266,256)	(134.1)
	Internal, Negotiated	\$420,417	23%	409	13%	(\$173,334)	(4.1)
	External, Negotiated	\$1,177,324	66%	2,051	63%	\$60,100	0.5
	Unknown	\$15,420	1%	18	1%	(\$5,978)	(3.9)
2002	Custody FX	\$235,531	6%	994	15%	(\$490,192)	(20.8)
	AIR	\$54,543	1%	709	10%	(\$678,159)	(124.3)
	Internal, Negotiated	\$808,388	21%	708	10%	(\$135,520)	(1.7)
	External, Negotiated	\$2,666,945	71%	4,374	64%	(\$510,101)	(1.9)
	Unknown	\$906	0%	6	0%	(\$3,504)	(38.7)
2003	Custody FX	\$202,018	5%	722	10%	(\$396,266)	(19.6)
	AIR	\$69,552	2%	767	10%	(\$735,868)	(105.8)
	Internal, Negotiated	\$1,013,000	27%	1,409	19%	\$546,892	5.4
	External, Negotiated	\$2,467,931	66%	4,591	61%	(\$824,229)	(3.3)
2004	Custody FX	\$621,665	11%	1,135	13%	(\$536,601)	(8.6)
	AIR	\$83,924	1%	1,021	11%	(\$704,658)	(84.0)
	Internal, Negotiated	\$1,515,424	27%	2,018	22%	(\$182,218)	(1.2)
	External, Negotiated	\$3,451,381	61%	4,860	54%	(\$177,496)	(0.5)
2005	Custody FX	\$184,297	7%	434	10%	(\$161,964)	(8.8)
	AIR	\$60,466	2%	636	15%	(\$446,317)	(73.8)
	Internal, Negotiated	\$978,222	35%	1,127	26%	(\$377,966)	(3.9)
	External, Negotiated	\$1,570,554	56%	2,084	49%	(\$580,158)	(3.7)
Total		\$17,776,934		30,851		(\$7,226,768)	(4.1)

Table 2.13 All spot executions by trade size, spot only

	Total	Market	Non-Market	Micro
Total value of all trades, \$000's	17,776,934	14,427,909	2,582,493	766,532
Excess benefit (+)/cost (-), \$000's	(7,227)	(4,796)	(1,407)	(1,023)
Benefit (+)/cost (-), bps	(4.1)	(3.3)	(5.4)	(13.4)
Total number of trades	30,851	8,139	8,913	13,799
Number with excess costs	17,710	4,417	4,886	8,407
Percentage disadvantageous by number	57%	54%	55%	61%
Value of disadvantageous, \$000's	9,443,476	7,591,497	1,417,110	434,869
Percentage disadvantageous by value	53%	53%	55%	57%
% within days range (by value)	96%	97%	92%	84%
% within days range (by number)	86%	96%	91%	77%

Table 2.14 All forward executions by trade size⁴

	Total	Market	Non-Market	Micro
Total value of all trades, \$000's	4,989,900	4,766,732	169,335	53,833
Excess benefit (+)/cost (-), \$000's	(1,955)	(1,932)	(10)	(12)
Benefit (+)/cost (-), bps	(3.9)	(4.1)	(0.6)	(2.3)
Total number of trades	2,185	754	586	845
Number with excess costs	1,144	400	307	437
Percentage disadvantageous by number	52%	53%	52%	52%
Value of disadvantageous, \$000's	2,627,366	2,509,970	89,848	27,548
Percentage disadvantageous by value	53%	53%	53%	51%
% within days range (by value)	98%	99%	97%	92%
% within days range (by number)	94%	97%	96%	91%

⁴ 436 forward executions (20% by number, 4% by volume) did not have sufficient data to statistically interpolate between near contracts; for these executions, valued at USD 189,253,549, we used the nearest, standard forward contract.

Table 2.15 Individual account results for SBA's foreign equity separately managed accounts, spot only

Accounts	Trades			% by value				Excess (cost) / benefit	
	Volume in # of trades	Volume in USD (000's)	Total	Internal,	Internal,	External,	USD (000's)	Bps of traded value	
				Non- Negotiated	Negotiated	Negotiated			
Acadian	672	483,922	100%	23%	4%	72%	0%	(304)	(6.3)
Artisan	2,999	1,512,093	100%	3%	94%	3%	0%	(944)	(6.2)
Bank of Ireland	303	170,254	100%	0%	90%	10%	0%	(8)	(0.5)
Britannic	915	537,810	100%	2%	39%	59%	1%	(121)	(2.2)
Capital Guardian	6,251	2,497,059	100%	2%	1%	97%	0%	(608)	(2.4)
Fisher	173	94,642	100%	93%	0%	7%	0%	(126)	(13.4)
Internal	351	235,751	100%	63%	15%	22%	0%	(331)	(14.0)
JP Morgan	2,530	760,202	100%	18%	7%	74%	0%	(493)	(6.5)
McLean Budden	294	320,982	100%	5%	0%	94%	0%	(17)	(0.5)
Mondrian	868	352,087	100%	20%	57%	23%	0%	(340)	(9.6)
Morgan Stanley	2,528	4,092,040	100%	0%	33%	67%	0%	341	0.8
New Star	343	503,005	100%	3%	96%	1%	0%	(357)	(7.1)
Putnam - SM82	3,695	2,011,744	100%	2%	8%	90%	0%	(1,127)	(5.6)
Putnam - SM9E	619	236,568	100%	1%	3%	97%	0%	0	0.0
Pyramis/Fidelity	3,179	1,202,602	100%	2%	7%	90%	0%	9	0.1
Sprucegrove	2,251	900,047	100%	100%	0%	0%	0%	(2,288)	(25.4)
T. Rowe Price	574	334,697	100%	2%	93%	2%	3%	(223)	(6.7)
Templeton - SM84	1,636	1,079,584	100%	0%	0%	100%	0%	(332)	(3.1)
Templeton - M9B	416	143,143	100%	0%	0%	100%	0%	(4)	(0.3)
UBS	254	308,702	100%	1%	79%	20%	0%	46	1.5
Total	30,851	17,776,934	100%	10%	27%	64%	0%	(7,227)	(4.1)

Table 2.16 SBA's "restricted" currencies results, spot only

Accounts	Trades			% by value				Excess (cost) / benefit	
	Volume in # of trades	Volume in USD (000's)	Total	Internal, Non- Negotiated	Internal, Negotiated	External, Negotiated	Unknown	USD (000's)	Bps of traded value
Brazilian real (BRL)	649	132,632	100%	100%	0%	0%	0%	(246)	(18.6)
Egyptian pound (EGP)	80	13,840	100%	0%	0%	100%	0%	(28)	(20.2)
Indonesian rupiah (IDR)	199	56,664	100%	100%	0%	0%	0%	(140)	(24.7)
Indian rupee (INR)	0	0	0%	0%	0%	0%	0%	0	0.0
S. Korean won (KRW)	1,003	586,942	100%	0%	0%	100%	0%	(801)	(13.6)
Moroccan dirham (MAD) ⁵	13	1,080	100%	0%	0%	100%	0%	(13)	(122.7)
Malaysian ringgit (MYR)	279	57,238	100%	97%	0%	3%	0%	(18)	(3.1)
Philippine peso (PHP)	291	26,132	100%	100%	0%	0%	0%	(27)	(10.4)
Thai baht (THB)	261	65,593	100%	5%	48%	45%	1%	(16)	(2.5)
Taiwan dollar (TWD)	126	203,960	100%	0%	0%	100%	0%	(85)	(4.2)
Total	2,901	1,144,082	100%	24%	3%	73%	0%	(1,375)	(12.0)

⁵ Mercer Sentinel considers 25 observations to be the minimum required for a statistically significant sample size

Appendix A

Foreign exchange transaction cost analysis methodology

There are two approaches to currency transaction cost analysis, depending on whether time-stamped trading data is available.

Time-stamped data

Where time of trade information is provided, a comparison is made between the actual price achieved and market prices available at or close to that time. Mercer Sentinel attains prices across a range of currencies every 15-minutes during market hours via Bloomberg pricing data. In a time-stamped analysis, we compare the traded price to the quoted market rate at the time of the trade, or a rate interpolated between the two nearest quoted prices on either side of the execution time. The results are presented graphically, grouping trades according to their variation from the interpolated rate ("market mid-price"). Effective trading would result in a tight grouping around the market mid-price with a bias to the less expensive side.

Price-makers can legitimately refuse to make general time-stamped data across their books available to third parties. However, custodians, acting as fiduciary agents for their clients, should be able to provide time-stamped trade data specific to the client. While it is common practice, it is poor internal control not to maintain time-stamped information.

Non time-stamped data

In some cases, custodians do not maintain time-stamped information, while in other cases time-stamped information is not available on external systems. In such situations, Mercer Sentinel must base FX audit analyses on the intra-day market price ranges: the highest and lowest execution prices during the transaction day. Mercer Sentinel assumes US Eastern Time as the basis for a trading day. For each day, we review the price range and calculate the midpoint from the high offer and low bid. Then, we

compare the actual execution price against the midpoint and daily range to determine its divergence from an anticipated trade during that specific day. For instance, if GBP/USD daily price range was 1.5000 to 1.5100, we calculate the midpoint at 1.5050 (assuming no bid-offer spread). If a manager purchased GBP and sold USD at a rate of 1.5050, Mercer Sentinel considers the trade 0% off market. If the transaction occurs at 1.5060, we consider the difference between the execution and midpoint at 20% off market. In this example, the trade would be more expensive to the client, and thus measured at -20%. Additionally, Mercer Sentinel considers a trade greater than +100% or less than -100% outside the relevant day's relevant price range.

Estimating excess costs for non-time stamped data

Statistically, relative positions of individual trades provide little information in isolation. For instance, a transaction may lie at the expensive end of its day price range due to the particular execution time in the market and may not necessarily signify an uncompetitive transaction. A reasonably sized sample should distribute executions across the spectrum from -100% to +100%, and coverage to a normal distribution, where the midpoint price is zero. For a normal distribution to hold, one must assume that over time the intra-day pattern of market prices is random in nature and normally distributed. If these assumptions are correct, significant divergences from a normal trade execution distribution⁶ over a portfolio of trades suggests that pricing has been systematically disadvantaged or advantaged.

Without adjusting for standard trading costs, such as bid-offer spreads, an FX analysis tends to produce a slight bias towards disadvantageous pricing. FX markets execute on a principal basis, with bid-offer spreads and generally no additional commissions. Bid-offer spreads mean that the price-taker pays for the price-makers services by purchasing at a higher price than it can sell to the price-maker at any particular time; thus, the price taker always incurs a slight disadvantage of the spread cost. Such a bias skews the trade execution distribution negatively, suggesting that the price-taker has received consistently non-competitive pricing.

To account for bid-offer spread, we adjust the rates traded by half the average bid-offer spread to reflect standing trading costs. The size of bid-offer spread adjustments vary among currency pairs, which we expect to be present on a typical competitive market-size trade. We calculate the bid-offer spread adjustment from quantitative historical data, and qualitative market experience.

Certain currency pairs in our analysis for SBA do not have significant bid-offer spread information. As agreed with SBA, we isolated these currencies and make special reference in the report where this absence of information materially affects our analysis.

⁶ A normal distribution is symmetric around the median and the number of observations gradually decreases as one moves away from the median. We would expect the median observation to be very close to 0%.

Trading pattern analysis

State Street's FX data did not include execution time-stamps, and hence, we have analyzed the data on a day-range basis. Mercer Sentinel considered the number and value of spot and forward trades analyzed sufficient to make use of the day-range methodology.

While interpreting our report, it is important to bear in mind that Mercer Sentinel evaluated trades based on divergence from the day's market midpoint. Execution on the negative side of the market midpoint incurs a cost to SBA. Execution on the positive side of the market midpoint delivers a benefit to SBA.

For example, during a currency purchase, if we found the trade to be 0% off market, then the trade was executed at the day's midpoint. If the purchase is +100% off the day's midpoint, the buy was executed at the day's low and, therefore, favorable to SBA; and -100% off the day's midpoint indicates a purchase at the day's high and, therefore, unfavorable to SBA.

Appendix B

Imputed spread by currency pair

Table B Imputed spread by currency pair

Currency	Spread	Currency	Spread	Currency	Spread	Currency	Spread
AUDEUR	0.0003	EEKUSD	0.0000	JPYEUR	0.0003	NZDUSD	0.0005
AUDGBP	0.0003	EGPUSD	0.0020	JPYGBP	0.0003	PHPUSD	0.0005
AUDUSD	0.0005	GBPEUR	0.0003	JPYHKD	0.0003	PLNUSD	0.0015
BRLUSD	0.0015	HKDAUD	0.0003	JPYSEK	0.0003	SEKCHF	0.0003
CADEUR	0.0003	HKDCAD	0.0004	JPYSGD	0.0003	SEKEUR	0.0003
CADGBP	0.0003	HKDCHF	0.0003	JPYTHB	0.0005	SEKGBP	0.0003
CADUSD	0.0003	HKDCNY	0.0010	JPYUSD	0.0003	SEKUSD	0.0003
CHFEUR	0.0003	HKDEUR	0.0003	KESUSD	0.0000	SGDEUR	0.0005
CHFGBP	0.0003	HKDGBP	0.0004	KRWUSD	0.0003	SGDGBP	0.0004
CHFUSD	0.0003	HKDSGD	0.0003	MADUSD	0.0000	SGDUSD	0.0003
CLPUSD	0.0000	HKDUSD	0.0000	MXNEUR	0.0005	THBEUR	0.0010
CZKUSD	0.0005	HUFUSD	0.0010	MXNHKD	0.0010	THBUSD	0.0003
DKKAUD	0.0003	IDRUSD	0.0020	MXNUSD	0.0003	TRYUSD	0.0010
DKKCAD	0.0003	ILSUSD	0.0020	MYRUSD	0.0003	TWDUSD	0.0003
DKKCHF	0.0003	JPYAUD	0.0005	NOKCHF	0.0003	USDEUR	0.0003
DKKEUR	0.0003	JPYCAD	0.0003	NOKEUR	0.0003	USDGBP	0.0003
DKKGBP	0.0003	JPYCHF	0.0003	NOKUSD	0.0005	ZARHKD	0.0010
DKKSGD	0.0005	JPYDKK	0.0003	NZDEUR	0.0003	ZARUSD	0.0003
DKKUSD	0.0003						

MERCER

Mercer (US) Inc.
155 North Wacker Drive, Suite 1500
Chicago, IL 60606
+1 312 917 9900

Consulting. Outsourcing. Investments.